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ABSTRACT:

Assets of banks located in France are mainly denominated in euro and in US dollar. Currency diversification, which measures how much of assets are denominated in US dollar, implies a credit risk diversification and a valuation effect on assets. As currency diversification affects directly the total converted value of assets, it changes banks' debt capacity and their resilience to economic shocks. Thereby, currency diversification of assets should affect leverage responsiveness to the value of assets, namely the leverage procyclicality. Using innovative data on credit institutions located in France between 1999 and 2014, we examine whether US dollar diversification of assets is pertinent for the analysis of leverage procyclicality. Focusing on investment banks, our results suggest that the net effect of US dollar diversification is dominated by the valuation effect. After extracting the valuation effect of diversification, it also posits the importance of two opposite effects in leverage procyclicality. Additionally, our results confirms the theoretical prediction where currency mismatch does not affect leverage procyclicality. Implicitly it supports the idea that leverage procyclicality is only driven by assets. Finally, our conclusions support the idea that US dollar diversification is relevant to the analysis of leverage procyclicality especially for the post crisis period.

JEL classification: F3, F4, G15

Keywords: banks, procyclical leverage, currency diversification, currency mismatch, financial accelerator.

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1 Introduction

The traditional models of financial accelerator from Bernanke and Gertler [1989], Kiyotaki and Moore [1997] posit that the procyclicality of asset prices amplifies booms and burst in financial cycle. During a boom asset prices increase which implies a strengthening of the banks' collateral value. Therefore, banks use their additional debt capacity to finance new credit. The ensuing credit expansion fuels cyclical upturn.

Recently, the financial crisis has redrawn researchers' attention on financial accelerator and more precisely on leverage procyclicality. The link between financial accelerator and leverage procyclicality is straightforward. During booms, asset prices increase and - for a given value of debt - it lowers leverage. If banks have a target leverage ratio, they would increase their debt in order to restore initial leverage. A procyclical leverage is then defined when banks do not target a constant leverage and take fully advantage of the increased asset prices. As posited by Adrian and Shin [2014], the dynamic of leverage is then only constrained by the Value at Risk rule. During booms banks extend their debts in order to keep their probability of default constant. [Adrian et al., 2012] show that leverage procyclicality also induces an endogenous mechanism similar to the financial accelerator.

Empirically, [Adrian and Shin, 2010] confirm the major five US investment banks' leverage procyclicality between 1997 and 2008. Kalemli-Ozcan et al. [2011] extend the analysis to large US and European banks. Although they do not distinguish investment banks from commercial banks, they confirm leverage procyclicality for either banks in the US or banks in Europe. Focusing on European banks Baglioni et al. [2013] extract investment banks from the total "universal bank" sample. They find that these investment banks show similar procyclical adjustment than US banks. Considering the

universal bank model of European banks their conclusions posit a leverage that is more procyclical than to their US counterpart. Finally, looking at Canadian banks Damar et al. [2013] also confirm a procyclical leverage of this institutions.

Although Angelini et al. [2009] provide a well detailed analysis on the sources of financial procyclicality, they do not include the potential impact of total asset's currency diversification. Theoretically, a bank's balance sheet is expressed in domestic currency thereby implying a converting process for assets initially denominated in foreign currency. Thus, bank's total collateral is also affected by this conversion. Additionally to the diversification on credit risk, currency diversification introduces an exchange rate channel - known as the valuation effect - on the dynamic of total assets. Following Pedrono [2015], the net effect of asset currency diversification is thus composed of two opposite effects. First, it implies a credit risk diversification which should reduce leverage procyclicality if the foreign asset is not perfectly correlated. Second, the valuation effect strengthens leverage procyclicality by promoting in the portfolio the asset that offers higher returns.

As highlighted by Borio and Disyatat [2011], Baba et al. [2009], McGuire and Von Peter [2012], European banks were largely involved in US money markets before 2008. This international development induces some degree of currency diversification of both assets and liabilities. Focusing on banks located in France, the average share of total assets denominated in foreign currency was around 0.3 in 2000. Despite the introduction and the development of the euro area, US dollar diversification remains significant with an average of 0.17 over the period 1999-2014.

Besides the recent renewed interest of academic literature in banking leverage issues, financial regulators have also been more and more focused on this topic over the past

few years. In 2010, the Basel Committee on Banking Supervision (BCBS) introduced a leverage ratio as a key component of the Basel III framework.[2] In the European Union, the leverage ratio requirement is still under review by the European Commission. Therefore, knowing that financial regulators are paying closer and closer attention to banking leverage, we believe that shedding light on the relations between currency diversification and leverage characteristics can also be of major interest for banking supervisors.

Thus, the purpose of this paper is to develop an empirical analysis on the link between leverage procyclicality of bank and US dollar diversification of assets. To do that, we use innovative micro data on credit institutions located in French between 1999 and 2014. Following Baglioni et al. [2013] we also extract investment banks from total universal banks.

This paper implies two main contributions. First, it fills the gap in the current empirical literature which does not include currency diversification in the analysis of leverage procyclicality. Second, we provide wide descriptive statistics on foreign currency exposure.

Our results confirm the presence of leverage procyclicality for banks located in France between 1999 and 2014. Regarding US dollar diversification and investment banks, our results suggest that the net effect of US dollar diversification is dominated by the valuation effect. Thereby, US dollar diversification increases leverage responsiveness to assets. By extracting the valuation effect of diversification, we show that it affects significantly investment banks' leverage procyclicality. It demonstrates the importance of the two opposite effects within the net effect. Additionally, our results confirm the theoretical

[2]In this paper, we define banking leverage as the ratio of assets divided by equity. In the regulatory perspective, the reverse is more frequently used: leverage ratio divides a capital measure by an exposure measure. Therefore, setting a minimum requirement to leverage ratio is strictly equivalent to setting a maximum on banking leverage. `http://www.bis.org/publ/bcbs189.pdf`

prediction where currency mismatch does not affect leverage procyclicality. Implicitly it supports the idea that procyclical leverage is only driven by assets. Finally, our conclusions support the idea that US dollar diversification is relevant to the overall analysis especially for the post crisis period.

The remainder of the paper is organized as follows. Section 2 provides a simplified theoretical framework based on Adrian and Shin [2010]. Section 3 describes the data set and provides details on the sample selection. Section 4 supplies descriptive statistics on currency diversification. We explain in section 5 our empirical approach while results are summarized in section 6.

2 Theory on leverage procyclicality

Following Adrian and Shin [2010, 2014], leverage procyclicality is derived from the definition of the Value at Risk (VaR) and the fact that banks are dynamic in the management of their balance sheets. Considering a random variable A for the value of assets at a given horizon, the VaR can be defined as the maximum loss V of asset value A_0 with given probability. Formally, the banks Value-at-Risk at confidence level c relative to some base level A_0 is smallest non-negative number V such that:

$$Prob(A \leq A_0 - V) \leq 1 - c \tag{1}$$

Then, the VaR rule stipulates that banks maintain a sufficient amount of equity E to cover potential loss V such that:

$$E = V \tag{2}$$

To be solvent, bank adjusts its exposure when the situation is more risky. Thereby, bank brings its VaR back in line with its equity.

Bank's leverage λ is defined as a ratio of total assets over equity such that:

$$\lambda = \frac{A}{E} = \frac{A}{V} = \frac{1}{v} \tag{3}$$

$$\text{where} : v = \frac{V}{A}$$

Where v is the unit VaR that we can interpret as a risk premium. As demonstrated in Adrian and Shin [2010, 2014], v is counter-cyclical. It means that leverage goes positively with total assets.

Introducing currency diversification changes the definition of total assets. Denote A the domestic asset in domestic currency and $A^\star$ the foreign asset in foreign currency. Thereby, total assets expressed in domestic currency is the sum of A and $SA^\star$ where S is the exchange rate. Leverage becomes:

$$\lambda = \frac{A + SA^\star}{E} = \frac{A + SA^\star}{V} = \frac{1}{v} \tag{4}$$

$$\text{where} : v = \frac{V}{A + SA^\star}$$

Adding a foreign asset changes the definition of the risk premium which now depends on both assets expressed in domestic currency. It follows that leverage is still positively related to total assets but this relationship depends on the degree of currency diversification. If both assets are positively correlated but not completely, and if the exchange rate regime is fixed, the introduction of a second asset diversifies the credit risk. Leverage

procyclicality is thereby reduced.

Consider a floating exchange rate regime with a cyclical domestic currency as euro is supposed to be. Following Pedrono [2015], floating exchange rate implies additional space capacity on banks balance sheets through a valuation effect. As balance sheets are expressed in domestic currency, the converting process affects the weight of assets within the bank's portfolio. Under these assumptions, a floating regime implies a growing share of the asset that offers higher returns. Space capacity on banks' balance sheets is thereby going up. Compared to fixed exchange rate, it increases procyclicality. However, it results from the combination of the two effects a decrease in leverage procyclicality.

Following this literature, currency diversification is challenging leverage procyclicality through its impact on total assets. Our main focus should be on the interaction term between total assets and currency diversification.

Additionally, the theoretical results suggest that currency mismatch is irrelevant for leverage procyclicality. As leverage is driven by the composition of assets, currency diversification of liability does not affect the relationship. This empirical analysis is a great opportunity to verify whether currency mismatch is pertinent.

3 Data set and sample selection

Our sample consists of french and foreign credit institutions located in France. Data are collected by the french banking supervision authority known as the ACPR. Data are on a yearly basis from 1999 to 2014. Because of bankruptcies, sample selection and merger acquisitions, our panel is unbalanced. We have a total of 529 observations over the period with a minimum of 21 observations in 2013 and a maximum of 43 observations in 2006.

The decline in observations since 2006 can be partly explained by the concentration of the french banking system.

A first sample selection is directly applied within the request conditions of the data. Thus, our data concern all institutions that are subject to the monetary statistic.[3] For the other institutions, there is a selection on the total amount in foreign currency of their balance sheets: institutions with less than 800 million euros in foreign currency are excluded to the sample.

We add two other sample selections to built sub-samples. First, we keep credit institutions which have a minimum of 5 years occurrence over the period. Second, we identify investment banks by following the methodology of Baglioni et al. [2013] except that we focus on the type of liabilities the bank uses. Thus, a credit institution is identified as an investment bank if its average ratio of deposit to total debt is lower than the median value of the total sample over the period.

The final data set brings together two types of data. First, we focus on classical accounting data. Those data can be collected at a different level of consolidation depending on the credit institution. For large and international institutions, data are consolidated using the IFRS accounting standards. Smaller parent institutions provide consolidated data and use french accounting standards (FRGAAP). Finally, stand-alone institutions provide unconsolidated data. With years, consolidated data becomes more and more dominant. In 2014, all the data are consolidated. As the three different levels of consolidation may imply different rules and definitions of the balance sheet components, we control for it in our analysis.

[3]It includes all institutions that are large enough to be under the scope of the ECB for the monetary policy.

The second type of data includes foreign currency exposures. On the asset side, we get the currency breakdown of credits and debt securities, while the liability is composed of total deposits and debt issued. The currency breakdown is given for 5 major currencies known as the euro, the US dollar, the Japanese yen, the Swiss franc and the Pound sterling.[4] As data are expressed in euro, the exchange rate channel is already included in the final degree of currency diversification.

Exposures in currencies are unconsolidated. As our interest is on the global analysis of banking groups, we need to build a proxy of consolidated diversification. The solution we choose consists in adding up currency exposures of all affiliates in the same banking group. Thereby, currency diversification of a banking group is measured through a ratio of total amount denominated in a given currency relative to the total amount in all currencies.

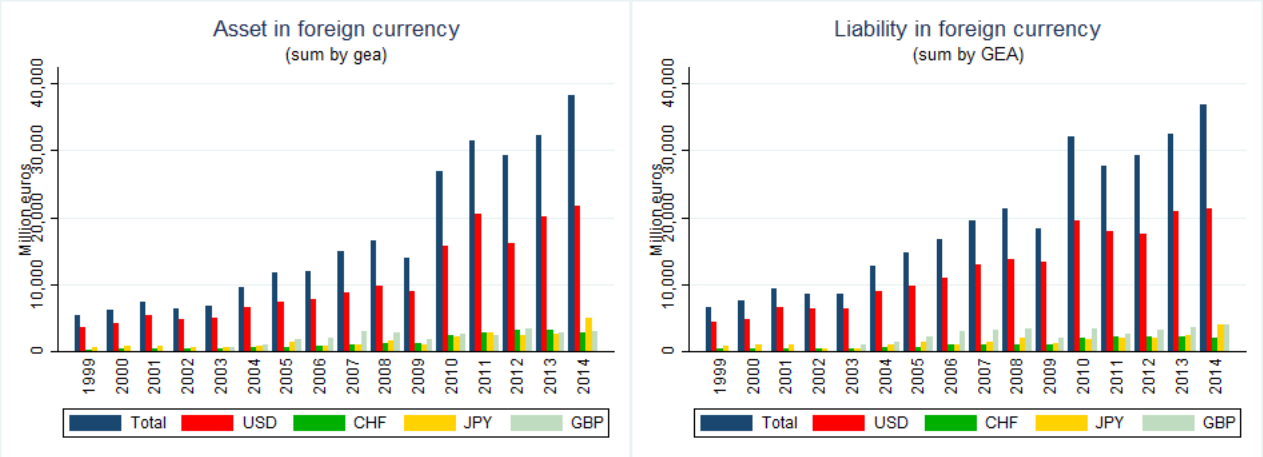
This measure may have two issues. First, there is a risk of a double counting because of intra-group flows. However, as long as diversification is a ratio, the double counting issue appears in both the numerator and the denominator. It mitigates the risk. Second, unconsolidated data do not include exposures of affiliates abroad. Thus, this measure of currency diversification might underestimate the true degree of diversification of a banking group.

An alternative of this measure of currency diversification consists in keeping the exposures of the head of the group only. However, this alternative shows really thin differences with our measure, except for cooperative banking groups. As cooperative banking groups are more decentralized, we believe that our measure better captures the overall currency diversification of these groups.

[4]The Pound sterling is only available since 2003. Before 2003, it was included in the "other" category.

4 Descriptive statistics

Figure 1 provides the foreign currency breakdown of assets and liabilities over the past fifteen years. For both sides of balance sheet, we observe a growing trend of activities denominated in foreign currencies as developed in Borio and Disyatat [2011], Baba et al. [2009], McGuire and Von Peter [2012]. Despite this global progression, two main shocks are observable. The financial crisis and the US dollar shortage stand out with the slowdown of 2008 and the decline of 2009, while the disturbances due to the euro area debt crisis show up in 2011 and 2012.



(a) Asset **(b)** Liability

Figure 1: Currency breakdown of foreign currency exposures

With no surprise, the US dollar is the first foreign currency for both assets and liabilities. Another currency also emerges from figure 1 especially in the recent years, the Japanese yen. As observed in McGuire and Von Peter [2012], the Japanese yen has always been part of the foreign assets and liabilities for the past twenty years. However, before the financial crisis European banks were also highly dependent on US money markets even for non US areas like Asian countries thereby creating an asymmetry in their

balance sheets. In the recent years, Japanese yen gains weight which might translate an adjustable strategy from European banks. It becomes the second foreign currency for assets in 2011 2013 and 2014 as illustrated in figure 1)a, and it is the second foreign funding currency in 2014 as illustrated in in figure 1)b. This recent evolution of the Japanese yen is also generalized worldwide. Between 2010 and 2013, Japanese yen has known the most important jump in trading activity according to BIS-Survey [2013].[5] The confirming recovery of banking activity in 2014 highlighted in BIS-Quarterly-Review [March 2015] has probably contributed to the 2014 yen boom in France. Among the advanced economies, the revival of cross-border bank lending to Japan stands out with a annual percentage changes larger than 15% for the second half of 2014. Additionally, between the end of 2010 and the end of 2014, the annual percentage changes of cross-border claims in Japanese yen was positive while the US dollar fluctuated between positive and negative percentage rates. Finally, the combination of large cross-border claims to Japan and accommodating monetary policy in Japan may have encourage french banks' funding in Japanese yen in 2014 as observed in figure 1)b.

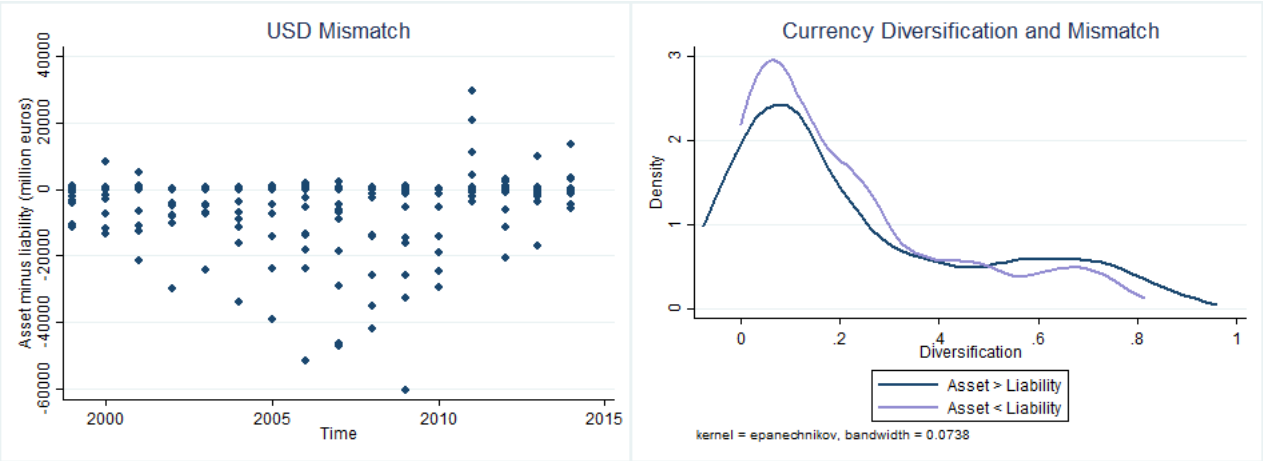
Figure 1 also highlights a potential currency mismatch between assets and liabilities with a dominance of the latter.[6] Focusing on US dollar exposures, figure 2)a. confirms the currency mismatch by plotting the difference between assets and liabilities denominated in US dollar for each banks. Despite the heterogeneity between credit institutions, the pre-crisis period is characterized by a growing US dollar currency mismatch which confirms the balance sheet asymmetry. In McGuire and Von Peter [2012], we find also negative foreign positions in US dollar in several periods before 2009.[7] In both analysis,

[5]Since the last survey in 2010, trading in Japanese yen increased by 63% and the turnover in the USD/JPY pair rose by 70% in this period. As a result, the yen expended its worldwide share in FX trading by 4%.

[6]These results might seem different to McGuire and Von Peter [2012] - where net foreign positions for French banks is positive - but it is not. We are looking at the positions in foreign currency where euro is excluded while it is included in their definition of all currencies net positions.

[7]Especially for 2001-2002Q2, 2003Q2-2003Q3, 2004Q4, 2005Q4, and 2008. However, they focus on

the crisis seems to have a readjustment effect where currency mismatches reduces since 2007.



(a) Currency mismatch **(b)** Mismatch and distributions (1999-2014)

Figure 2: Currency mismatch

Theoretically, currency mismatch is not supposed to affect leverage procyclicality. However, we include this dimension in our analysis in order to see whether it is relevant or not. We identify with a dummy credit institutions that have a positive mismatch with higher assets in foreign currency and credit institutions with a negative currency mismatch. With such a distinction, we might think that the dummy would capture the degree of currency diversification of assets but it is not. Figure 2)b. plots the currency diversification of assets for the two types of credit institutions. As both distributions include high degree of currency diversification and similar shape, the introduction of the mismatch position might not diminish the effect of diversification in regressions.

Currency diversification implies two effects on total assets. First it introduces a diversification in credit risk if assets are sufficiently different. Second it induces a val-

net foreign positions while we focus on net positions including domestic and foreign positions.

uation effect due to conversion. Figure 3) illustrates the contribution of pure valuation effect in US dollar diversification. Share of assets denominated in US dollar with euro area counterparty should not imply a credit risk diversification while shares relative to non-residents induce both effects for reporting banks. Following the red bars, the pure valuation effect due to currency diversification had increased between 2000 and 2007. After the crisis, US dollar diversification mainly concerns non-resident counterparty.

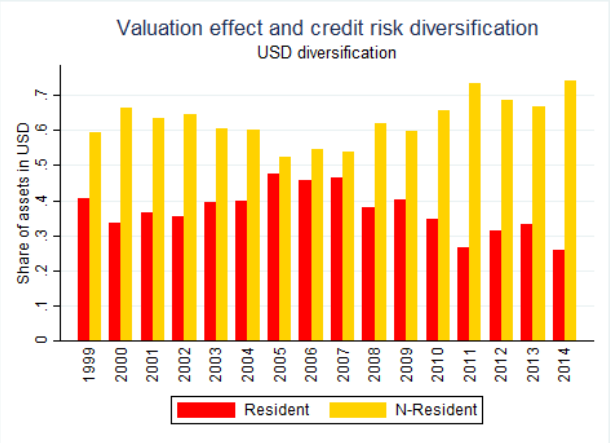


Figure 3: Currency diversification of assets: Resident includes all euro area counterparty while "N-Resident" excludes euro area counterparty. Bars are for average shares of assets in USD related to each counterparty. Only banks that have a US dollar diversification are included in this graph.

Finally, table 1 presents summary statistics for ΔLeverage and ΔAsset respectively the annual growth rate of leverage and the annual growth rate of assets. Diver is the US dollar currency diversification and US dollar diversification with resident counterparty is defined through Diver_RES.[8] The standard deviation, minimum and maximum confirm the presence of heterogeneity in our sample.

[8]The complete definitions of variables are provided in the appendix.

Table 1: Summary statistics
These summary statistics are for the complete sample over the period 1999-2014. This table presents variable averages, standard deviation, minimum and maximum. Variable definitions are provided in the appendix.

Variable	Mean	Std. Dev.	Min.	Max.	N
Leverage	16.04	12.67	1.14	78.68	529
ΔLeverage	-0.02	0.25	-1.43	1.19	444
ΔAsset	0.03	0.22	-1.6	1.1	444
Diver	0.17	0.2	0	0.84	529
Diver_RES	0.05	0.09	0	0.67	529

5 Empirical specification

Adrian and Shin [2008] develop an error correction model which links changes in leverage with changes in asset value, thereby confirming the procyclicality of leverage. By showing a strong and positive relationship, they demonstrate that financial intermediaries adjust their balance sheets actively. In their model, the dependent variable is the log difference of leverage $\Delta Leverage$ and the variable of interest is the log difference of total assets $\Delta Asset$. Thanks to this specification they also highlight that leverage is a mean reverting process with a negative relationship between the dependent variable and the lagged value of leverage in log.

As explained in section 2 currency diversification should challenge leverage procyclicality through its impact on total assets. We introduce in this model an interaction variable between changes in assets and US dollar diversification at the previous period thereby capturing the impact of the initial currency diversification. We add $Divers$ which measures the degree of US dollar diversification at the previous period. $Divers$ is part of the control variables as our interest is really on the interaction term.[9] The

[9]Our variable of interest is constructed by interacting an exogenous term $Divers$ with the potentially endogenous variable $\Delta Asset$. As we control for the effect of the endogenous variable, our interaction term can be interpreted as exogenous (Angrist and Krueger [1999]). See also Bun and Harrison [2014] for a related discussion.

complete specification is of the form:

$$\begin{aligned}\Delta Leverage_{i,t} = \alpha + \beta_1\, ln\,(Leverage_{i,t-1}) + \beta_2\, \Delta Asset_{i,t} \\ + \beta_3\ (\Delta Asset_{i,t}\ \text{x}\ Divers_{i,t-1}) + \beta_4\, Divers_{i,t-1} \\ + \delta\, Controls + \gamma FE_{time} + u_{i,t} \qquad \text{(PRO)}\end{aligned}$$

Where Δ represents the difference between t and $t-1$. We introduced three control variables in $Controls$ in addition to $Diver$. First, we define a ratio of total off-balance to total assets and we keep the log-difference of it. This variable would control for hedging strategy. Second, we use a dummy $Conso$ which is equal to 1 if the data are consolidated. Finally, we introduce another dummy $IFRS$ which is equal to 1 if credit institutions are under the IFRS accounting standards. These two dummies control for the different sources we have explained in section 2. They are also taken in difference. As we want to see whether the mismatch position is relevant or not for leverage procyclicality, we introduce in some specifications a dummy $Mismatch$ which is equal to 1 if total assets denominated in foreign currency are higher than total liabilities denominated in foreign currency. Finally, we control time fixed effect in order to capture crisis and changes in regulation. $u_{i,t}$ is the term of error.

6 Empirical findings

6.1 A global vision from 1999 to 2014:

Table 4 reproduces similar results as in Adrian and Shin [2008]. With a negative and significant coefficient for all specifications, we can confirm the mean reverting process of leverage. All coefficients relative to the growth rate of assets are positive and significant thereby confirming leverage procyclicality. The largest level of leverage procyclicality is observed when we focus on investment banks with repeated occurrences as in column

(2+3).

Our main variable of interest known as the interaction variable between the growth rate of assets and the lagged US dollar diversification is positive for all samples and has a significant coefficient for investment banks. These first results goes against the theory prediction at least for the investment banks in (3). Theoretically, the valuation effect is supposed to be dominated by the effect of credit risk diversification. The absence of significance may illustrate this two opposite effects in (1), (2) and (2+3), while valuation effect seems to dominate in (3).

Table 5 goes further on the two different channels of currency diversification. Our previous measure of US dollar diversification does not allow us to distinguish between the credit risk diversification and the valuation effect due to exchange rate fluctuation. Instead of using the total US dollar diversification of assets, we might use the US dollar diversification of assets with domestic counterparty Divers_RES to capture the pure valuation effect. As assets are linked to resident only, this new measure removes the risk credit diversification. Table 5 reports the results with the variable Divers_RES. Our main variable of interest - the interaction term between the growth rate of assets and the US dollar diversification - is positive and significant for all investment banks and investment banks with at least five years occurrence. These results confirm the presence of a valuation effect of US dollar diversification on leverage through the dynamic of total assets. Compared to results from table 4 where the coefficient of the interaction term is equal to 0.56 for investment banks, coefficient grows to 2.86 when diversification only induces domestic counterparty. Therefore, our results confirm the presence of two opposite effects within US dollar diversification. There is a positive valuation effect and a negative credit risk diversification effect. Our results support the theoretical conclusions of Pedrono [2015].

Banking leverage is supposed to be driven by the dynamic of assets, thereby putting liabilities aside. As demonstrated in theory, a currency mismatch should not affect leverage procyclicality. We introduce in table 6 the mismatch position in order to check this assumption. Coefficients are not significant for all samples and this additional variable does not increases the adjusted R^2 compared to the previous table. This result is in line with the theoretical conclusion. As leverage is mainly driven by collateral, currency mismatch which induces the liability of banks should not affect leverage procyclicality.

6.2 A two periods decomposition:

Our analysis is over a long period from 1999 to 2014. It includes two main sub-periods. On the one hand, from 1999 to 2007 the euro has been lunched and developed. This first sub-period has been characterized by growing enthusiasm around the unique currency and its potential as a leading international currency. It is also associated with large leveraging and a continuous appreciation of the euro from the end of 2000. On the other hand, from 2008 to 2014 the euro area financial system has been hit by several shocks such as the propagation of the subprime crisis in 2008, the banking crisis, the Greek debt crisis in 2011 and the different threats of euro area exit since then. Additionally, the second sub-period is also characterized by a renewal of regulation and a deleveraging. Therefore, the two sub-periods decomposition allows us to see whether the relationship is symmetric or not.

Table 7 decomposes the 1999-2014 period into two sub-periods known as 1999-2007 and 2008-2014 for the pre-crisis and the post-crisis period respectively. Despite the lack of significance for the mean reverting process in the post-crisis sub-period, results from Adrian and Shin [2008] are still valid and there is no complete reversal of the situation between the pre-crisis and the post-crisis sub-period.

Conversely, the role played by US dollar diversification of assets seems to be more specific to sub-periods. Regarding our main variable of interest the interaction term, our results suggest that the post-crisis sub-period is much more relevant for the impact of currency diversification. Coefficients are positive and significant for all samples.

This difference between the two sub-periods may come from the dynamic of the exchange rate euro-dollar. The pre-crisis period is characterized by a long-term appreciation of the euro while the post-crisis sub-period is subject to financial distress with sharp exchange rate fluctuations and zero bound monetary policy. Considering this environment, the valuation effect of US dollar diversification clearly dominates the credit risk diversification in our analysis. Thereby, US dollar diversification may have magnified leverage responsiveness to total assets.

6.3 Additional findings

This section adds several results from different specifications we think interesting to study. Instead of looking at the US dollar currency diversification, we focus on the total foreign currency diversification in order to capture the complete currency diversification. Coefficients and significance of variables linked to diversification decrease. As this variable captures different currencies it may induces several exchange rate fluctuations which may play an opposite role. The US dollar diversification is in this sens more precise.

An alternative to the current accounting definition of leverage is the Basel III definition which replaces equity by TIER1 and adds the off balance sheet to total assets. With this new definition, leverage is less procyclical or even no procyclical. Our results are in line with previous literature.

The dummy $Mismatch$ is quite limited in its definition because it does not capture the size of the mismatch. An alternative is to define a ratio of the currency mismatch over total assets. However, this new measurement definitely captures the degree of currency diversification of assets.

Finally, it might be interesting to underline the fact that off-balance sheet ratio is not irrelevant to the leverage analysis even though we introduce currency diversification. Our results suggest that currency diversification has to be included in banking monitoring even if banks have hedging strategies.

Conclusion

Using an innovative data set on credit institutions located in France between 1999 and 2014 enables us to examine whether currency diversification is relevant for leverage procyclicality. Theoretically, as currency diversification of assets affects directly the total value of assets, it changes their debt capacity and the procyclicality of their leverage.

This paper implies two main contributions. First, it fills the gap in the empirical literature which does not include currency diversification in the determinants of leverage. Second, we provide interesting descriptive statistics on foreign currency exposures.

Our results confirm previous conclusions on leverage procyclicality. Furthermore, it suggests that US dollar diversification is relevant to the analysis of the leverage procyclicality of investment banks . It posits the domination valuation effect over the credit diversification effect. Therefore, US dollar diversification increases leverage responsiveness to assets. Additionally, our results confirms the theoretical prediction where currency mismatch does not affect leverage. Implicitly it supports the idea that leverage is only

driven by the asset of banks.

Considering all samples we look at, the effect of US dollar diversification depends on the type of banks and the sub-period decomposition. US dollar diversification expresses itself more easily within investment banks. Regarding the crisis decomposition, our results suggest that the post-crisis period is more relevant for capturing the impact of US dollar diversification on leverage procyclicality.

Finally, our analysis is based on the idea that banks do not target a constant leverage. However, the new Basel III regulation would impose in the near future a new leverage ratio which aims at limiting leverage procyclicality. Thus, we might turn our interests on the effect of currency diversification on the bank's stability when leverage is exogenous.

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7 Appendix

.1 Variable definitions

Table 2: Variable definitions

Main variables:	
$Leverage$	$\frac{Assets}{Equity}$
Δ $Leverage$	Growth rate of leverage
Δ $Asset$	Growth rate of assets
$Divers$	$\frac{Assets\ denominated\ in\ USD}{TotalAssets}$
$Divers\_RES$	$\frac{Assets\ denominated\ in\ USD\ with\ resident\ conterparty}{TotalAssets}$
$Invest.$	=1 if $\left(\frac{Deposits}{Total\ Debts}\right)_i < \left(\frac{Deposits}{Total\ Debts}\right)_{median(i...N)}$
$Mismatch$	=1 if $Assets\ in\ foreign\ currency\ >\ Liabilities\ in\ foreign\ currency$
Controls:	
FR	=1 if banks are french
$Sub\ Cat.$	Breakdown credit institutions between banks, cooperative banking groups and other
$Conso$	=1 if data are consolidated
$\Delta Conso$	Changes in $Conso$
$IFRS$	=1 if banks report data using IFRS standards
$\Delta IFRS$	Changes in $IFRS$
$Off\ BS$	$\frac{Off-balance\ sheet}{Assets}$
$\Delta Off\ BS$	growth rate of $Off\ BS$

.2 Correlation

Table 3: Variance co-variance matrix (1999-2014)

	$\Delta Leverage$	$\Delta Asset$	$Diver.$	$Diver\_RES$	$Invest.$	$Mismatch$
$\Delta Leverage$	1					
	444					
$\Delta Asset$	0.6229*	1				
	0					
	444	444				
$Divers$	-0.0361	-0.0681	1			
	0.4477	0.1518	0			
	444	444	529			
$Divers\_RES$	0.0643	0.0095	0.6160*	1		
	0.1764	0.841	0			
	444	444	529	529		
$Invest.$	0.0301	0.0258	0.2840*	0.2394*	1	
	0.5266	0.588	0	0		
	444	444	529	529	529	
$Mismatch$	-0.0148	-0.1131*	0.0728	0.0317	-0.0322	1
	0.7552	0.0171	0.0942	0.4673	0.4601	
	444	444	529	529	529	529

.3 Empirical results

.3.1 Leverage Procyclicality

Table 4: Procyclical leverage and US dollar diversification

Dependent variable : $\Delta Leverage_t$

	(1)	(2)	(3)	(2+3)
$ln\,(Leverage_{t-1})$	-0.04***	-0.05***	-0.05***	-0.06***
	(0.01)	(0.01)	(0.02)	(0.02)
$\Delta Asset_t$	0.74***	0.81***	0.72***	0.86***
	(0.10)	(0.11)	(0.13)	(0.14)
$\Delta Asset_t$ x $Divers_{t-1}$	0.04	0.07	0.56*	0.58
	(0.28)	(0.31)	(0.30)	(0.42)
$Divers_{t-1}$	-0.10	-0.14	-0.02	-0.10
	(0.08)	(0.08)	(0.12)	(0.09)
$\Delta conso$	-0.04	-0.03	-0.16*	-0.15
	(0.07)	(0.08)	(0.08)	(0.09)
$\Delta Off\ BS$	-0.00	0.01	-0.02	0.01
	(0.02)	(0.01)	(0.02)	(0.02)
$\Delta IFRS$	0.08	0.09	0.12	0.10
	(0.06)	(0.06)	(0.10)	(0.11)
$Constant$	0.12**	0.15**	0.15**	0.20**
	(0.05)	(0.06)	(0.06)	(0.07)
Adjusted R^2	0.44	0.50	0.55	0.63
N	412	367	210	191

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Four samples are studied: (1) is the unconstrained sample with all banks ; (2) includes banks with a minimum of 5 years occurrence over the period ; (3) focuses on investment banks ; (2+3) is for investment banks with a minimum of 5 years occurrence. Standard errors are clustered. LSDV include sub-category of banks and banks' nationality. Time Fixed-Effects included.

Table 5: Procyclical leverage, US dollar diversification and pure valuation effect

Dependent variable : $\Delta Leverage_t$				
	(1)	(2)	(3)	(2+3)
$ln\,(Leverage_{t-1})$	-0.03***	-0.04***	-0.05***	-0.05**
	(0.01)	(0.01)	(0.02)	(0.02)
$\Delta Asset_t$	0.74***	0.80***	0.67***	0.81***
	(0.09)	(0.10)	(0.12)	(0.11)
$\Delta Asset_t$ x $Divers\_RES_{t-1}$	-0.01	-0.02	2.86***	2.85***
	(1.10)	(1.17)	(0.82)	(0.78)
$Divers\_RES_{t-1}$	-0.25	-0.27	0.09	-0.08
	(0.28)	(0.31)	(0.27)	(0.25)
$\Delta conso$	-0.03	-0.01	-0.16**	-0.16*
	(0.07)	(0.08)	(0.08)	(0.09)
$\Delta Off\ BS$	-0.00	0.00	-0.03	0.01
	(0.02)	(0.01)	(0.02)	(0.02)
$\Delta IFRS$	0.06	0.07	0.14	0.12
	(0.06)	(0.06)	(0.10)	(0.11)
$Constant$	0.07**	0.07*	0.14**	0.17**
	(0.04)	(0.04)	(0.06)	(0.07)
Adjusted R^2	0.44	0.49	0.57	0.64
N	412	367	210	191

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Four samples are studied: (1) is the unconstrained sample with all banks ; (2) includes banks with a minimum of 5 years occurrence over the period ; (3) focuses on investment banks ; (2+3) is for investment banks with a minimum of 5 years occurrence. Standard errors are clustered. LSDV include sub-category of banks and banks' nationality. Time Fixed-Effects included.

Table 6: Procyclical leverage, US dollar diversification and currency mismatch position

Dependent variable : $\Delta Leverage_t$

	(1)	(2)	(3)	(2+3)
$ln\,(Leverage_{t-1})$	-0.04***	-0.05***	-0.06***	-0.06***
	(0.01)	(0.01)	(0.02)	(0.02)
$\Delta Asset_t$	0.73***	0.80***	0.70***	0.85***
	(0.10)	(0.11)	(0.13)	(0.13)
$\Delta Asset_t$ x $Divers_{t-1}$	0.06	0.08	0.59*	0.61
	(0.28)	(0.31)	(0.30)	(0.41)
$Divers_{t-1}$	-0.10	-0.14	-0.02	-0.10
	(0.08)	(0.08)	(0.11)	(0.09)
$Mismatch_{t-1}$	-0.03	-0.01	-0.03	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
$\Delta conso$	-0.05	-0.03	-0.15	-0.15
	(0.08)	(0.08)	(0.09)	(0.10)
$\Delta Off\ BS$	-0.00	0.01	-0.02	0.01
	(0.02)	(0.01)	(0.02)	(0.02)
$\Delta IFRS$	0.08	0.09	0.12	0.10
	(0.06)	(0.06)	(0.10)	(0.11)
_cons	0.14**	0.14**	0.17**	0.21***
	(0.06)	(0.06)	(0.07)	(0.07)
Adjusted R^2	0.44	0.50	0.55	0.63
N	412	367	210	191

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Four samples are studied: (1) is the unconstrained sample with all banks ; (2) includes banks with a minimum of 5 years occurrence over the period ; (3) focuses on investment banks ; (2+3) is for investment banks with a minimum of 5 years occurrence. Standard errors are clustered. LSDV include sub-category of banks and banks' nationality. Time Fixed-Effects included.

Table 7: Procyclical leverage, US dollar diversification and crisis decomposition

Dependent variable : $\Delta Leverage_t$

	(1)	(2)	(3)	(2+3)
$ln\,(Leverage_{t-1})$	-0.05***	-0.06***	-0.06**	-0.07**
	(0.01)	(0.01)	(0.02)	(0.03)
Post-crisis x $ln\,(Leverage_{t-1})$	-0.01	-0.02	-0.04**	-0.05**
	(0.02)	(0.02)	(0.02)	(0.02)
$\Delta Asset_t$	0.71***	0.80***	0.70***	0.83***
	(0.12)	(0.14)	(0.14)	(0.15)
Post-crisis x $\Delta Asset_t$	0.85***	0.82***	0.86***	0.90***
	(0.08)	(0.09)	(0.12)	(0.12)
$\Delta Asset_t$ x $Divers_{t-1}$	-0.04	-0.14	0.69*	0.92
	(0.33)	(0.40)	(0.36)	(0.61)
Post-crisis ($\Delta Asset_t$ x $Divers_{t-1}$)	0.52***	0.62***	0.48**	0.37*
	(0.19)	(0.20)	(0.20)	(0.21)
$Divers_{t-1}$	-0.11	-0.14	0.12	0.00
	(0.09)	(0.10)	(0.13)	(0.12)
Post-crisis x $Divers_{t-1}$	-0.09	-0.13*	-0.16	-0.17
	(0.07)	(0.07)	(0.14)	(0.14)
Post-crisis dummy	-0.07	-0.03	0.00	-0.01
	(0.07)	(0.08)	(0.12)	(0.12)
Constant	0.11*	0.12*	0.11	0.17
	(0.06)	(0.06)	(0.10)	(0.10)
Adjusted R^2	0.45	0.50	0.55	0.62
N	412	367	210	191

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Four samples are studied: (1) is the unconstrained sample with all banks ; (2) includes banks with a minimum of 5 years occurrence over the period ; (3) focuses on investment banks ; (2+3) is for investment banks with a minimum of 5 years occurrence. Standard errors are clustered. LSDV include sub-category of banks and banks' nationality. The table decomposes each coefficient relative to two sub-periods: the pre-crisis period from 1999 to 2007 and the post-crisis period from 2008 to 2014. Not all control variables shown. Time Fixed-Effects included.